

Thermoplastic Piping and Ozone Applications

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YES – Asahi America sells pipe too !!



Thermoplastic Piping Systems

Industrial/Environmental



Proline



C.G. PVDF



E-CTFE Halar



Air Pro HDPE



Duo Pro



FluidLok



PolyFlo



ProLock

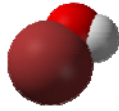
Leak Detection Systems



Why Thermoplastics for Ozone?



Question "why is this an issue"?



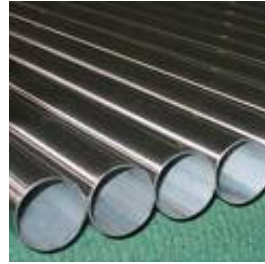
HOBr
Hypobromous Acid

+



NaCl
Sodium Chloride

+



Stainless Steel Pipe

=



Stainless Steel – the good

- SS is corrosion resistant because of its ability to form a protective coating.
- This coating is a “passive film” which resists further oxidation or rusting.
- The formation of this passive layer is instantaneous in an oxidizing atmosphere such as air, water, or other fluids that contain oxygen.



Stainless Steel – the good con't.

- Once the material is “passivated”, the corrosion rate decreases to less than .002” per year.
- Unlike aluminum or silver, the passive film is invisible in stainless steel.
- It is created when oxygen combines with the chrome to form chrome oxide, also known as “ceramic”, which is corrosion resistant to most materials.



Stainless Steel – and now the bad

- Halogen salts, especially chlorides easily penetrate this passive film and allow corrosion to occur
- Halogens such as fluorine, chlorine, bromine, iodine, and astatine are leaders of corrosion in stainless steel.
- Halogens form binary compounds with hydrogen, known as hydrogen halides,
- HF, HCL, and HBr are examples of very strong acids.



Stainless Steel – and now the END

- General corrosion occurs when there is a overall breakdown of the passive layer.
- It is easy to recognize as the material has a “coral sponge” appearance.
- The rate of attack is affected by the fluid concentration, temperature, velocity and stress in the metal parts (i.e. threaded connections).
- Corrosion creates a buildup and causes restrictions, reducing flow.







PVDF INDUSTRIAL PIPING the solution



- Size Range
 - 120 psi: 3" - 12"
 - 232 psi: 1/2" - 10"
- Molded Fittings
 - 1/2" - 12": all sizes
- Fabricated Fittings
 - 1-1/2" - 12"
- Butt & Socket Fusion



PVDF – the great

- Polyvinylidene fluoride (PVDF)- is a thermoplastic polymer with a wide operating range of -80°F to 300°F.
- Asahi America/ AGRU/ Solvay has tested PVDF pipe made from Solvay Solef Resin, 1000 series.
- The pipe was installed at the Georgia Aquarium, after the original stainless steel piping failed, after a short period of time (<3 months).



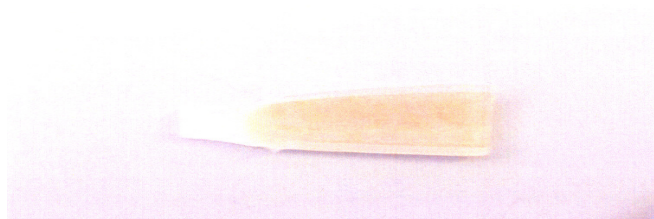
PVDF – the great

- The PVDF pipe was in service for approximately 2 years running 2-5% ozone concentration.
- A sample of the pipe was removed and sent to the resin manufacturer, Solvay.
- Several tests were conducted, included visual, optical microscope (100x), IR spectroscopy, and Differential Scanning Calorimetry (DSC) and Melt Flow Index (MFI) and a hydrostatic burst test.



PVDF – the results

- **Visual-** Brownish stains were seen on the sample, as seen in the following photo.



- The stains were easily wiped off, which most likely indicated, they are not linked to a modification in the chemical structure of the PVDF material.



PVDF – the results

- **IR Spectroscopy-** The superficial deposit was taken and analyzed by IR Spec. in transmission mode, it was found to contain mostly inorganic carbonates and water.
- The PVDF pipe sample was also looked at in reflection and transmission mode, and results observed were typical of PVDF.



PVDF – the results

- **Differential Scanning Calorimetry (DSC)**- A sample of the pipe was also analyzed which confirmed the typical crystallinity values for Solef PVDF homopolymer.
- **Melt Flow Index (MFI)**- The melt flow of a pipe portion was measured and usual values for Solef PVDF 1010/0001 resin was found.
- **MFI (230°C, 5kg)=5.32 g/10 min**- indicates that the molecular weight is virtually unchanged compared to new Solef PVDF resin.

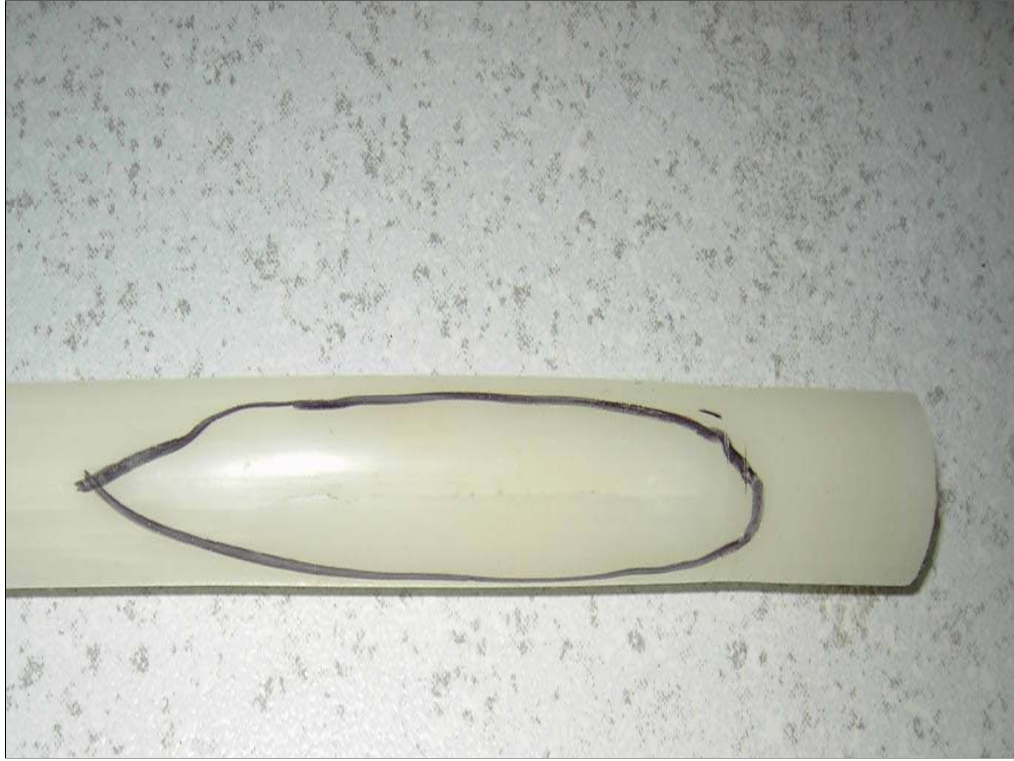


PVDF – the ultimate TEST

- The PVDF pipe sample was hydrostatically tested with very positive results;
- According to ISO 10931, PVDF in SDR21 (230 psi rating) has to withstand the pressure test for a *minimum* of **40** hours.
- The ozone exposed pipe was subjected to 30°C (86° F) at 35 Mpa stress (**5076 psi**), and the pipe burst at **273** hours (Minimum required, 40 hours in accordance with ISO 10931).

This internal pressure equates to 1232 psi.





PVDF – Conclusions

- The Solef PVDF pipe sample tested from the Georgia Aquarium after 2 years exposure to ozone gas and byproducts, did not show any deviation from the typical properties of Solef PVDF 1010/0001 resin.
- It is thus concluded that no sign of chemical attack to the PVDF material could be identified.



PVDF - Installation

- PVDF pipe is thermally welded using several methods.
- There are no glues, cements, or solvents used in the process.
- Small diameter pipe and fittings (< 1-1/2") can be easily welded by hand.
- Transition fittings can be machined to tie into existing lines.
- A hand held pipe threader allows easy connection point for transition fittings.



Socket-Fusion

Handheld socket welder for pipe and fittings 1-1/4" and under.



Bench socket welder for pipe and fittings 1-1/2" and above.



Installation: **Socket Fusion**

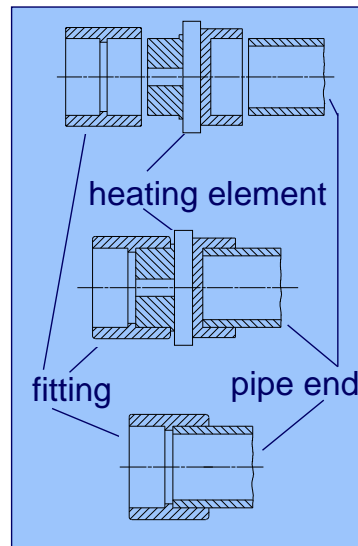
- Preparation of the weld area



Pre-heating



Joining and cooling



Butt Fusion Welder

MiniPlast Bench Top
(up to 4" pipe)

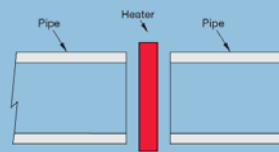


Disconnects from base
for Field Welding

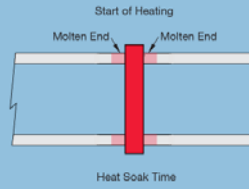


Butt Fusion

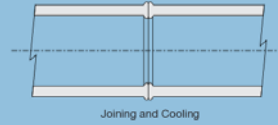
Preparation of the weld area



Pre-heating under pressure



Joining and cooling under pressure



Socket Welding Parameters

- Heat for the indicated time on chart.

Nominal Pipe Size (inches)	Heat Soak Time (sec)	Adjusting Time (sec)	CoolingTime (min)
1/2	3	3	3
3/4	4	3	3
1	5	3	3
1-1/4	6	4	4
1-1/2	8	4	5
2	10	5	6

- After heating time is finished, quickly remove pieces from the mirror and fit them together until both welding beads meet. Allow time to cool.



Installation Tools

Handheld power threader Handheld socket welder





**PVDF Connection - at top of old
"Hartford" loop**

Note: hand threader allowed threading SS pipe
close to wall



Transition Fittings

PVDF union

- Machined SS end connector to match PVDF union

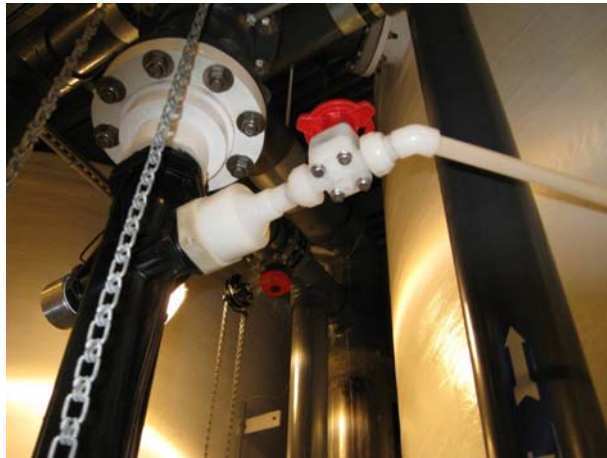
PVDF Female adapter

- Standard part for connection to injector





PVDF Diaphragm Valve for isolation



PVDF connection at 2" venturi inlet
2" PVDF female adapter with a 2" x 1/2" spigot x
socket reducer



PVDF valves for ozone use



Ball Valve – for isolation



Ball Check Valve



Diaphragm Valve – for flow control



PVDF discussions

- NFPA 1, Annex G section G.5.2 states;
- "Secondary containment, such as double wall piping or exhausted enclosures, shall be provided for piping, valves, fittings and related components. Secondary containment shall be capable of directing a sudden release to an approved treatment system."

(Exception: Welded stainless steel piping and tubing)

Our test results show that Purad PVDF has worked very well in salt water applications, exceeding the performance of stainless, and a case can be made to view this material suitable for use as both single wall and double wall systems.



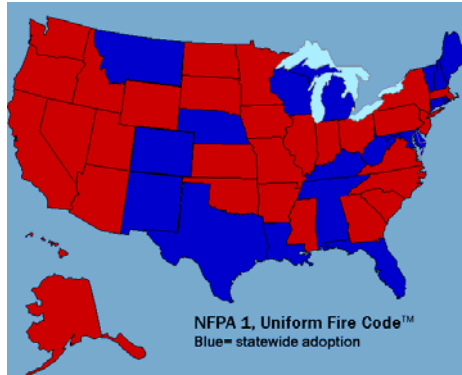
PVDF discussions

- NFPA 1, Annex G section G.5.3 states;
- “Materials shall be compatible with ozone and shall be rated for design operating pressure.”

In salt water applications it has been shown that stainless pipe and fittings can often fail, and should be held to the same standard as non-stainless systems.



PVDF discussions



Annex G is not part of the NFPA document
unless specifically adopted by local
jurisdiction.





PVDF discussions

- If NFPA 1, Annex G has been adopted for your local codes, a variance can be requested thru the local fire marshal or building officials.
- With proper ambient ozone leak detection and proper shutdowns, safety is maintained with PVDF, as is if stainless steel were installed and developed leaks.



10 things to remember about pipes

- Pipe is used to move media from point A to B.
- Operating pressure of thermoplastic pipe is dependant on operating temperature. (Temp  Pressure )
- Remember to shut off your pump, when discharge valve is closed (see above point regarding temperature).
- There are many thermoplastic materials engineered for various needs, consult your favorite piping engineer for assistance.
- PVC or CPVC should never be used for compressed air or gases.
- Some pipes are UV resistant and other are not, check with piping manufacturer.
- SDR ratings are the ISO standard for pressure ratings on pipe, (SDR = OD/ wall thickness) The lower the number the higher the pressure rating. Wall thickness remains the same throughout size range.

10 things to remember about pipes

- ANSI schedule 40 and 80 pipe have different wall thicknesses within their pressure ranges.
- Fittings are used to change the direction of pipe flow, add connections for instruments, valves and equipment.

- And the number #1 thing to remember about pipes is;

- The ID is ALWAYS smaller than the OD!

Thank you for your time



and always remember

The beauty is in the eye of the beerholder.



THE
END

